The Evolution of the Mars Exploration Rover

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In 2003, two powerful new Mars rovers will be on their way to the red planet. With far greater mobility than the 1997 Mars Sojourner rover, these robotic explorers named Mars Exploration Rover (MER) will greatly expand our knowledge of the geological processes of Mars. Each MER rover will carry a sophisticated set of instruments that will allow it to search for evidence of liquid water that may have been present in the planet's past. The rovers will be identical to each other, but will land and operate at different regions of Mars. MER will have direct heritage from the Sojourner rover and from a series of technology rovers that were developed in the subsequent years. In each of the rovers, lightweight composite structures are enabling technology and have led to set the stage for the design of the current MER rovers. In the development phase for the Sojourner rover, designing the structure for the thermal environment was a primary design factor. It relatively small size and weight (11.5 kg) allowed and lightweight integrated thermal and structure design for its primary structure, called the Warm Electronics Box (WEB) using aerogel insulation. The first follow-on technology rover in 1997 after Sojourner was the Lightweight Survivable Rover (LSR). Its goal was to develop an advanced rover that had a high stowage volume efficiency and lighter mass. LSR was had twice the wheel base and width and weighed only 5.5 Kg. Composites were critical in reducing the mass and providing a collapsible and deployable structure. LSR also had the first small composite robotic arm for soil sample acquisition, which would become a primary technology feature of subsequent rovers. After the success of LSR, the robotics team in 1998 was given the challenge of developing a rover capable of lightweight, fast, continuous and autonomous operation for the collection of a sample return container. The result was Sample Return Rover (SRR). SRR was also 5 kg in mass, had an all composite instrument and grappling arm and Kevlar/Graphite collapsible wheels. In 1999, NASA made the decision to delay a sample return mission and focus on long duration exploration of the Mars surface. As a technology development testbed, the Field Integrated Design &Operation (FIDO) Rover was created. FIDO is on the size and scale of the proposed Athena rover and became the technology demonstrator for the MER flight rover. Composites are featured in the solar array strongback which used an optimized egg crate core design to transfer mechanical loads and to reduce mass, a 1.5 meter high stiffness composite mast to support the navigation cameras and a lightweight composite instrument arm.

MER, currently in development, has direct heritage from all of these rovers. It will use aerogel insulation in a composite WEB as its primary structure. Because of its size and mass (150 kg), the WEB is now primary structure that is being designed for strength and stiffness, as well as thermal insulation. The composite instrument and deployment arms developed on LSR, SRR and FIDO have provided the baseline for the MER instrument deployment device (IDD). The composite mast for FIDO has enabled the PANCAM mast and the composite FIDO strongback helped resolve some of the early design problems for the MER rover equipment deck (RED) and deployable solar arrays.

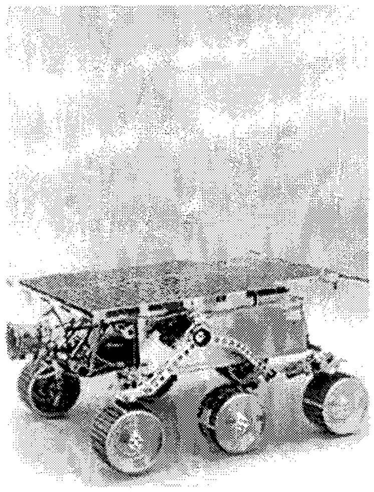

Figure 1: Sojourner Rover

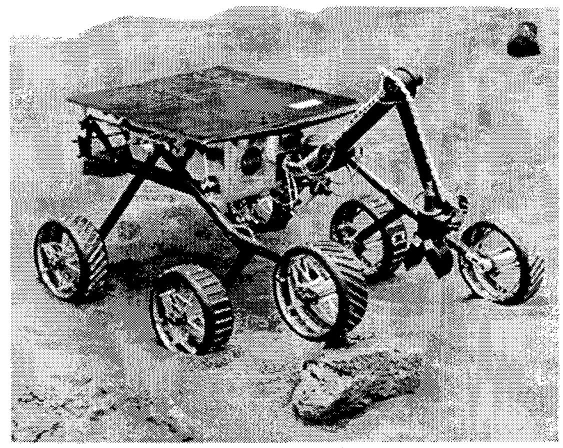

Figure 2: Lightweight Survivable Rover (LSR)

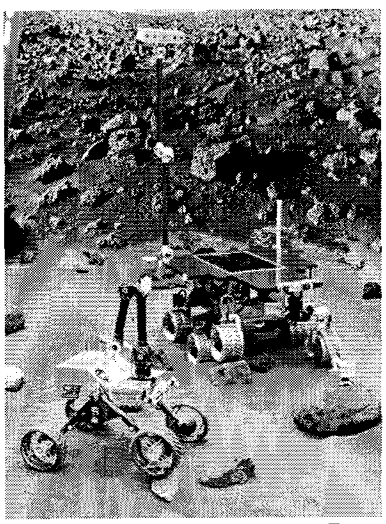

Figure 3: Sample Return Rover (SRR) and Field Integrated Design &Operation (FIDO) Rover

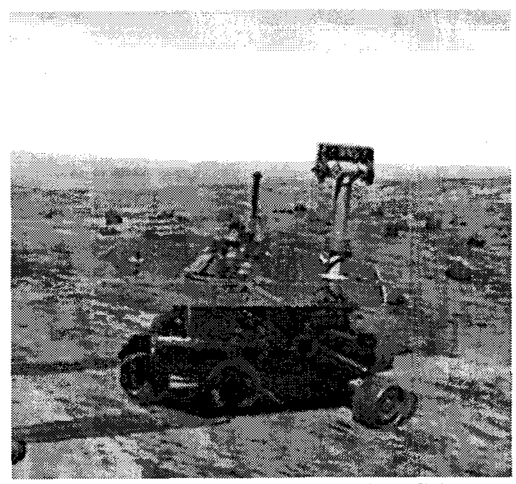

Figure 4: Mars Exploration Rover (MER)